TIROS SPACE INFORMATION

NEWS BULLETIN

68TH IAC ADELAIDE 2017

Vol. 41 No.5, February 2016
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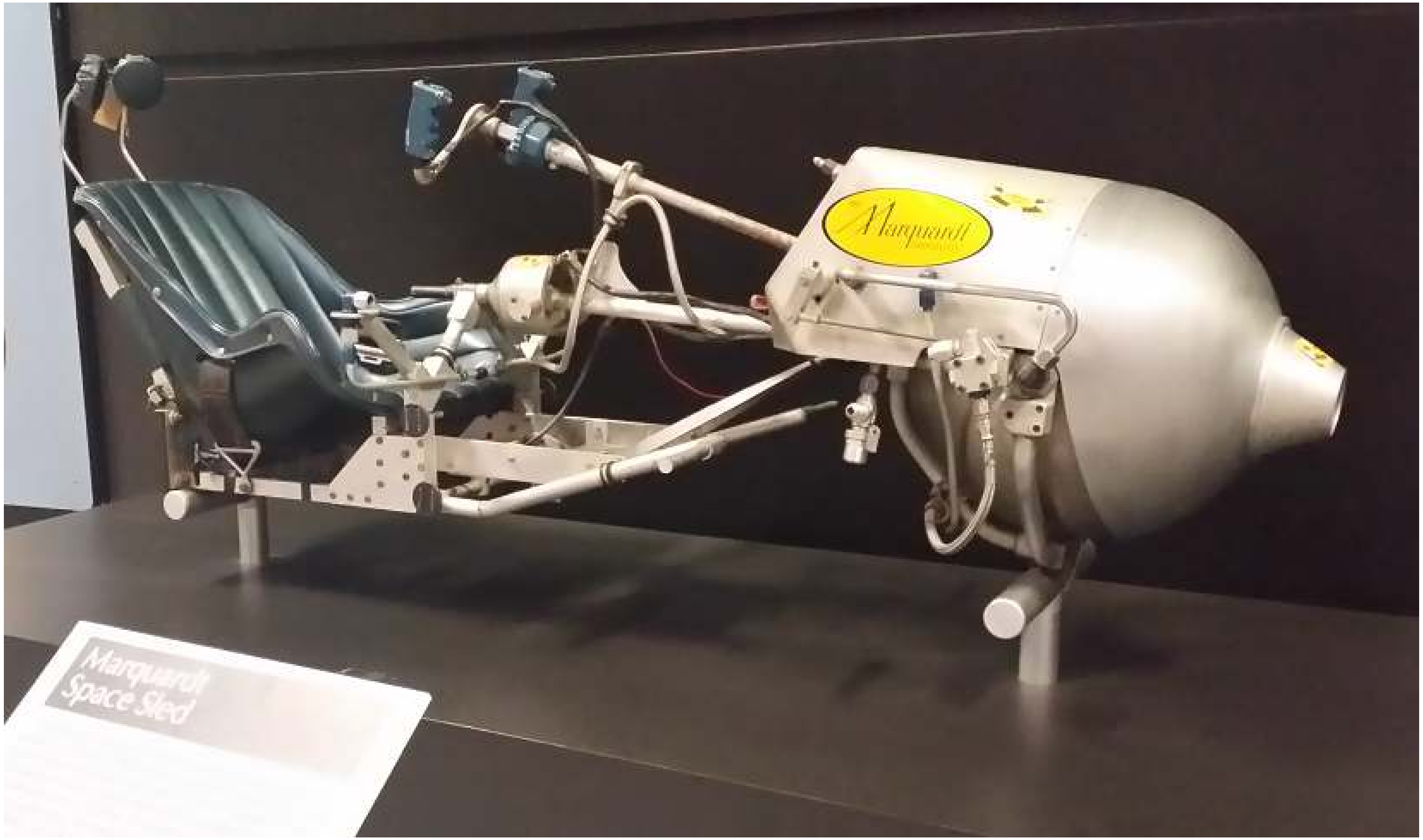
In this issue:

Satellite Update	3
Crew Mobility In Space (part 2)	4
News	
Apstar-5C	2
Arianespace's 2016 launch schedule	7
Chang'e-4	7
Dream Chaser	7
Elektro L-2	3
India's 2016 launch schedule	2
Inmarsat 6	2
MUSIS	7
Telstar-18 Vantage	2
WFOV	2



Marquardt Space Sled

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The *Tiros Space Information (TSI) - News Bulletin* is published to promote the scientific exploration and commercial application of space through the dissemination of current news and historical facts.
In doing so, Tiros Space Information continues the traditions of the Western Australian Branch of the Astronautical Society of Australia (1973-1975) and the Astronautical Society of Western Australia (ASWA) (1975-2006).
The News Bulletin can be received worldwide by e-mail subscription only. Subscriptions can be requested by sending an e-mail address to tirosspace@hotmail.com. Tiros Space Information reserves the right to refuse any subscription request without the need to provide a reason.
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Calling card...

Since writing the first instalment of the Crew Mobility In Space series, as published in last month's News Bulletin, I ran across the Marquardt Space Sled, displayed in the National Museum of the Air Force, in Dayton, Ohio, USA. Actually I saw the unit when visiting the museum in September last year but somehow forgot about it until I recently attempted to sort out the many photos I had taken.

The space sled was manufactured by Marquardt in the mid-1960s as an experimental propulsion unit for individual maneuvering in the vicinity of a spacecraft. The 2 m long frame had a mass of about 100 kg and could have carried one astronaut. It was designed in support of the Gemini project but was not selected for production and the requirement was, instead, met by the Astronaut Maneuvering Unit (AMU).

Other sources have suggested it was developed for the MOL project and that it was tested in 1965.

Whilst the information on the Marquardt Space Sled brings us probably closer to an explanation of the mysterious Space Taxi that was shown in last month's News Bulletin, I would still like to hear from anybody who can identify that Space Taxi.

Jos Heyman

Inmarsat 6

Inmarsat has ordered two mobile communications satellites from Airbus Defence and Space using the Eurostar E3000e platform. To be known as Inmarsat 6, the satellites will carry payloads that support L band and Ka band services. They will be fitted with a large 9-meter aperture L-band antenna and nine multibeam Ka-band antennas. A modular digital processor will provide full routing flexibility over up to 8,000 channels and dynamic power allocation to more than 200 spot beams in L-band. Ka-band spot beams.
Inmarsat 6-F1 is expected to be launched in 2020.

Telstar-18 Vantage/Apstar-5C

Telesat, the Canadian operators of the Telstar series of satellites and APT, the Hong Kong operator of the Apstar series of satellites, have decided to continue their joint use of the Telstar-18/Apstar-5 communications satellite located at 138^{o}E with a new satellite designated as Telstar 18 Vantage/Apstar-5C. The satellite, to be launched in early 2018 and to be located at 138^{o}E as well, will be built by Space Systems/Loral and will carry 63 C and Ku band transponders. The satellite will be legally owned by Telesat.

WFOV

The US Air Force hopes to launch an experimental Wide Field Of View (WFOV) missile early warning satellite in 2018/19.
It is intended that this satellite will operate from a geosynchroneous orbit and it is expected that commercial satellite companies will submit information on their capability to launch the missile warning satellite.

India's 2016 Launch Schedule

India plans to launch 9 satellites in 2016.
The next three IRNSS 1 navigational satellites will be launched in January (already launched), February and March 2016 respectively using SLV-XL launch vehicles. These three launches will complete the constellation.
Three new Earth observation satellites, known as Scatsat (June 2016 possibly with a PSLV-XL), Oceansat-3 (July 2016 with a GSLV Mk. 2) and Resourcesat-2A (December 2016 with a PSLV-XL) will also be launched.
In the field of communications satellites two, identified as GSAT-17 and GSAT-18, will be placed in orbit on separate Ariane 5ECA launch vehicles.
Finally, in December 2016, it is planned to launch the first Geosynchronous Satellite Launch Vehicle (GSLV-Mk. 3 which will place the GSAT-11 heavy communications satellite in orbit. This satellite is expected to transform the country's telecommunications and broadcasting operations.

Satellite Update

Launches in December 2015

Int.Des.	Name	Launch date	Launch vehicle	Country	Notes
2015 070A	LISA Pathfinder	3-Dec-2015	Vega	ESA	Scientific
2015 071A	Kosmos-2511	5-Dec-2015	Soyuz 2.v.1/Volga	Russia	Earth observation
2015 071B	Kosmos-2512	5-Dec-2015	Soyuz 2.v.1/Volga	Russia	Technology
2015 072A	Cygnus Orb-4	6-Dec-2015	Atlas V-401	USA	Cargo to ISS
2015 073A	Zhongxing-1C	9-Dec-2015	CZ 3B	China	Communications
2015 074A	Elektro L-2	11-Dec-2015	Zenit 3SL-B/Fregat	Russia	Earth observation
2015 075A	Kosmos-2513	13-Dec-2015	Proton M/Briz M	Russia	Communications
2015 076A	Soyuz TMA-19M	15-Dec-2015	Soyuz FG	Russia	Crew to ISS
2015 077A	Velox C-1	16-Dec-2015	PSLV CA	Singp.	Technology
2015 077B	KR-1	16-Dec-2015	PSLV CA	Singp.	Technology
2015 077C	Athenoxat-1	16-Dec-2015	PSLV CA	Singp.	Technology
2015 077D	TeLEOS-1	16-Dec-2015	PSLV CA	Singp.	Technology
2015 077E	Galassia	16-Dec-2015	PSLV CA	Singp.	Technology
2015 077F	Velox-II	16-Dec-2015	PSLV CA	Singp.	Technology
2015 078A	Wukong	17-Dec-2015	CZ 2D	China	Scientific
2015 079A	Galileo FOC-9	17-Dec-2015	Soyuz 2-1b/Fregat MT	ESA	Navigation
2015 079B	Galileo FOC-8	17-Dec-2015	Soyuz 2-1b/Fregat MT	ESA	Navigation
2015 080A	Progress MS-1	21-Dec-2015	Soyuz 2-1A	Russia	Cargo to ISS
2015 081A	Orbcomm FM-114	22-Dec-2015	Falcon 9 v1.2	USA	Communications
2015 081B	Orbcomm FM-119	22-Dec-2015	Falcon 9 v1.2	USA	Communications
2015 081C	Orbcomm FM-105	22-Dec-2015	Falcon 9 v1.2	USA	Communications
2015 081D	Orbcomm FM-110	22-Dec-2015	Falcon 9 v1.2	USA	Communications
2015 081E	Orbcomm FM-118	22-Dec-2015	Falcon 9 v1.2	USA	Communications
2015 081F	Orbcomm FM-112	22-Dec-2015	Falcon 9 v1.2	USA	Communications
2015 081G	Orbcomm FM-113	22-Dec-2015	Falcon 9 v1.2	USA	Communications
2015 081H	Orbcomm FM-115	22-Dec-2015	Falcon 9 v1.2	USA	Communications
2015 081J	Orbcomm FM-108	22-Dec-2015	Falcon 9 v1.2	USA	Communications
2015 081K	Orbcomm FM-117	22-Dec-2015	Falcon 9 v1.2	USA	Communications
2015 081L	Orbcomm FM-116	22-Dec-2015	Falcon 9 v1.2	USA	Communications
2015 082A	Ekspress AMU-1	24-Dec-2015	Proton M/Biz M	Russia	Communications
2015 083A	GF-4	28-Dec-2015	CZ 3B	China	Earth observation

Other updates

Int. Des.	Name	Notes
1998 067FV	Flock 1d'-2	Re-entered 27 December 2015
1998 067GU	Arkyd-3R	Re-entered 23 December 2015
2003 055A	Gruzomaket	Re-entered 15 December 2015
2013 064L	Prometheus 1-4	Re-entered 13 December 2015
2013 064M	Prometheus 1-2	Re-entered 10 December 2015
2013 064Q	Prometheus 1-6	Re-entered 10 December 2015
2013 064V	Prometheus 1-7	Re-entered 5 December 2015
2013 064X	Prometheus 1-8	Re-entered 1 December 2015
2013 064Y	SwampSat	Re-entered 13 December 2015
2013 064AC	Prometheus 1-1	Re-entered 12 December 2015
2013 064AE	Vermont Lunar Cubesat	Re-entered 8 December 2015
2015 031A	Progress M-28M	Undocked and re-entered 19 December 2015
2015 035A	Soyuz TMA-17M	Undocked and re-entered 11 December 2015
2015 071A	Kosmos-2511	Re-entered 8 December 2015

During 2015 a total of 230 satellites were placed in orbit through 83 launches or through deployment from the International Space Station. Three launch failures resulted in the loss of 23 satellites.

Elektro L-2

Parts of the second stage of the Zenit launch vehicle that placed the Elektro L-2 satellite in orbit, crash landed in Vietnam on 1 January 2016.
Earlier that day the brake-up of the 8000 kg stage was seen over Thailand, Laos and Vietnam, accompanied by sonic booms.

Amongst the debris found were three metal spheres with diameters between 27 and 80 cm with Russian writing on them. The spheres may have held reaction control system propellant or tank pressurant gases.

Crew mobility in space (part 2)

By Jos Heyman

Space Shuttle

When originally conceived, one of the roles for the Space Shuttle was the in-orbit repair of satellites. In addition it was expected that tiles on the underbelly of the orbiter might have to be repaired whilst in orbit.

To undertake these tasks effectively a Manned Maneuvering Unit (MMU) was designed to increase the mobility of astronauts beyond the tether lines. In the development early technology tests had been taken during the Skylab mission with the M509 astronaut maneuvering unit but these test were within the confines of the Skylab.

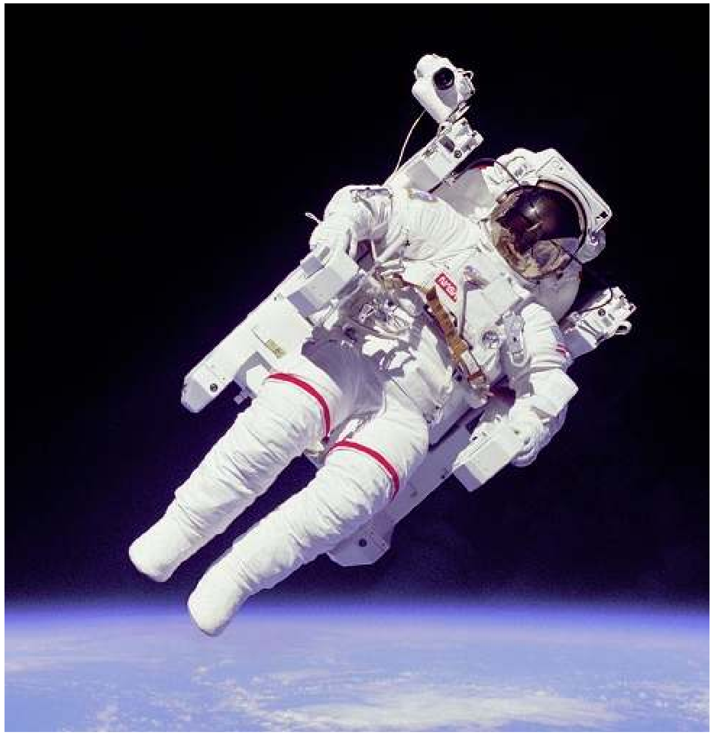
M509

Martin Marietta built three MMUs which were 1.25 m high, 0.83 m wide and 1.21 cm deep. They had a mass was 148 kg.

When needed for a mission, two MMUs were carried in the orbiter's payload bay near the airlock hatch. The astronaut backed into it and the MMU attached to his life support system. The armrests were then unfolded and adjusted to the need of the individual astronaut.

The MMU used gaseous nitrogen as the propellant. This propellant was kept in two aluminium tanks, sufficient for a six hour EVA.

The 24 nozzle thrusters at different locations on the MMU, were controlled by hand controllers at the end of each MMU arm, with the right controller producing rotational acceleration for roll, pitch, and yaw and the left controller producing translational acceleration for moving forward-back, up-down, and left-right. Through the effective coordination of these two controllers, intricate movements could be performed. There was also an automatic attitude-hold function that could be engaged to maintain a specific attitude, allowing the astronaut to use his hands for other activities.
Although a top speed of 64 km/h would have been possible, the operating speed was 1.6 km/h.



McCandless EVA on STS-41B

The MMU was first tested on the STSD-41B mission when on 7 February 1984 astronauts Bruce McCandless and Bob Stewart tested one of the MMUs carried achieving distances of up to 100 m.
On 9 February 1984 they made another EVA this time using the second MMU that was carried in the orbiter. This time they flew around the SPAS-1 structure to test some techniques required for the SMM recovery planned for the next mission. It had been intended to move the SPAS-1 framework out of the payload bay using the Remote Manipulator System (RMS) of the orbiter but an electrical fault in the RMS prevented this.

STS-41C – SMM recovery

The Solar Maximum Mission (SMM) satellite was recovered during the STS-41C mission. During the first attempt on 8 April 1984 astronaut George Nelson used the MMU to fly to the SMM. The intention was to grapple the satellite with the Trunion Pin Attachment Device (TPAD), a device mounted between the hand controllers of the MMU. This would have stopped the rotation of SMM so that it could be placed in the payload bay using the Shuttle Remote Manipulation System (SRMS). Unfortunately the TPAD failed to lock into SMM, and eventually Nelson used his hands to grab hold of an SMM solar array and tried to stop the spinning by a push from MMU's thrusters. Instead, this attempt caused the satellite to tumble out of control, before being stabilised by ground control operators. The SMM was subsequently captured by the SRMS, taken into the payload bay and repaired, following which it was released again. During the repairs astronaut James Van Hoften used the MMU.

STS-51A

The final MMU mission was STS-51A, which was to retrieve and repair Westar VI and Palapa B2, two communications satellites that failed to reach their proper orbit due to faulty propulsion modules. Astronauts Joseph Allen and Dale Gardner used the MMUs to capture the two satellites and brought them into the Orbiter payload bay for stowage and return to Earth.

Following the Challenger disaster of 28 January 1986 NASA discontinued the use of the Space Shuttle for commercial launches. In addition the three operations with the MMU had indicated that the activities undertaken by the MMUs could be done equally effectively with the manipulator arms or traditional tethered EVAs.

Consequently the two units that had been flown, MMU #2 and #3, were stored in a clean room until 1998 when NASA transferred MMU #3 to the National Air and Space Museum. In 2013 MMU #2 was displayed next to the Space Shuttle Atlantis in its new home at the Kennedy Space Center Visitor Complex. It is believed that MMU #1, which never flew, is still stored with NASA. Models of the MMU are displayed in several other places.

SAFER

On 17 September 1994 STS-64 astronauts Mark Lee and Carl Meade tested the Simplified Aid For EVA Rescue (SAFER) device during an EVA, SAFER was designed to stabilise an astronaut who would drift away from the spacecraft and bringing the astronaut back to the spacecraft. Designed with the International Space Station (ISS) in mind, where a large number of astronauts might be involved in construction, the unit was not designed to fly large components from one place to another. The unit operated with 24 nitrogen thrusters and had a maximum speed of 10 km/h. The pack strapped on the astronaut's back and did not contain back-up systems. During the four tests the astronauts conducted, the first familiarised them with the operation of the unit. The two astronauts performed some engineering tests within the confines of the orbiter payload bay and then conducted a range of rescue scenarios at the end of the Remote Manipulator Arm, ending with flying around the arm.

SAFER tests

It was again tested during flight STS-92 when astronauts Peter Wisoff and Michael Lopez-Alegria performed test maneuvers, flying up to 15 m while remaining tethered to the spacecraft.

SAFER is now a standard feature during spacewalks but to date there has not been an emergency in which it was needed.

ISS

Although at one stage the MMU was envisioned as an essential aid for use during and after the construction of the International Space Station, NASA developed different tethered spacewalk approaches for ISS. In addition there is now a tendency towards the use of robotic devices such as the Robonaut.

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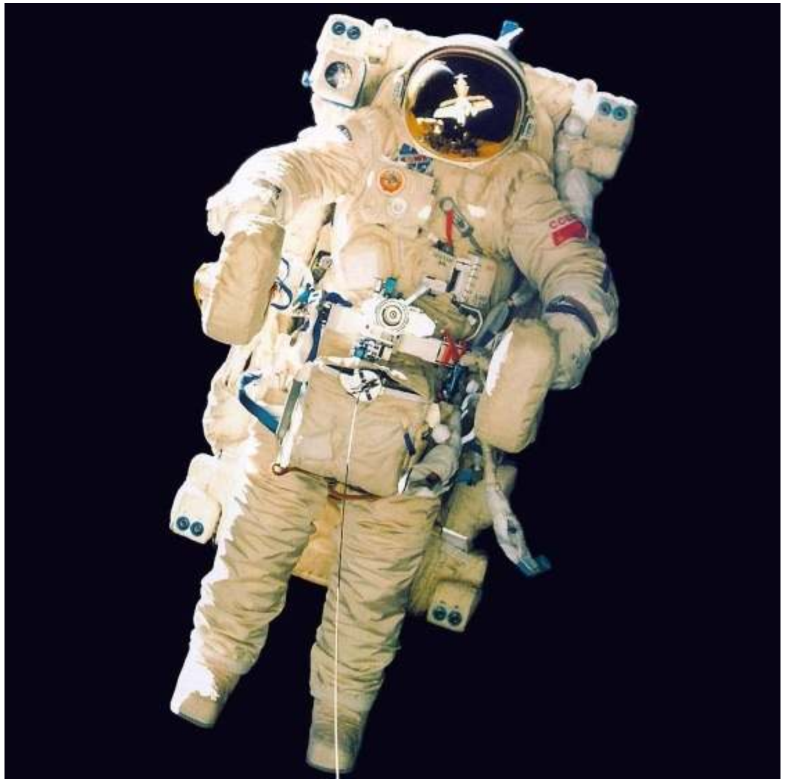
SPK

Russia also developed a maneuvering unit like the MMU. Designated as SPK or UPMK and UMK, it was tested by Soyuz TM-8 cosmonauts Alexander Serebrov and Alexander Viktorenko during their EVAs from the Mir space station on 1 February 1990 and 5 February 1990. Both of these EVAs were tethered.



SPK

After the tests the SPK was initially stored inside the Kvant-2 module but, when storage space a problem, the SPK was attached outside the Kvant-2.
At one stage it was considered for use it as a dead end mass for the Mir Electrodynamic Tether System (METS), in which a 5 km tether wire and a 1 km long bare metal strip would maintain Mir's orbit by using power generated from the Earth's magnetic field. METS was never flown and the SPK unit burned up in the atmosphere as part of the Mir space station complex.

The future

Whilst there is evidently no place for a crew mobility system during the ISS operations, it can be expected that future missions to the Moon and may be Mars, will see the development of such vehicles again for surface transportation.

MUSIS

France has initiated work on the next-generation optical imaging spacecraft, signals intelligence and satellite communications project identified as Multinational Space-based Imaging System (MUSIS). It will do so in cooperation with Germany in exchange for access to a next-generation German radar satellite observation system, known as SARah.
Airbus Defense and Space will be the prime contractor whilst Thales Alenia Space will provide the main instrument.

Arianespace's 2016 launch schedule

Kourou will see 11 Arianespace launches in 2016.
The first one is scheduled for 27 January 2016 when an Ariane 5ECA will place the Intelsat-29e communications satellite in orbit.
On 9 March 2016 Eutelsat-65 West A will be launched by another Ariane 5ECA.
A Soyuz 2-1a/Fregat MT rocket will place the Sentinel-1B Earth observation satellite in orbit on 12 April 2016 along with the Norsat-1 microsatellite and ESA's CubeSat.
In May 2016 an Ariane 5ECA will place the EchoStar-18 and BRIsat communications satellites in orbit.
In July 2016 a Vega vehicle will place the PeruSat-1 surveillance satellite for the Peruvian government and four high-resolution SkySat commercial imaging satellites in orbit.
Four Galileo navigational satellites are scheduled for launch with an Ariane 5ECA in October 2016.
In late 2016, another Vega rocket will deploy the Gokturk-1A Earth observation satellite in orbit.

Arianespace has not finalized and disclosed payload pairings for the other four Ariane 5ECA launches in 2016 but possible payloads are Intelsat-32e, JCSat-15, GSat-16, Telkom-3S, Star One-D1, Hispasat-1AG, Koreasat-7 and Al Yah-3.

Chang'e-4

The next Chinese moon mission, Chang'e-4, is now scheduled for launch in June 2018 with a CZ 3B vehicle.
The spacecraft, which was originally a back-up to Chang'e-3, is to land on the far side of the Moon and will deploy a rover vehicle.
The modified spacecraft will study the geological conditions at the landing site and low-frequency radio waves for which it will carry, amongst others a frequency spectrograph. It is understood the Aitkin Basin, a 2575 km diameter impact crater with a depth of 13 km, will be the landing site.
To enable communications, the mission will be accompanied by a relay satellite that will be placed at the L2 Libration point.

Dream Chaser

The fleet of NASA's space station re-supply spacecraft will be increased by the acceptance of the automatic space plane being developed by Sierra Nevada.

To be flown for the first time in 2019, the Dream Chaser spacecraft can carry 5500 kg but, unlike the other participants in the fleet, SpaceX's Dragon and Orbital ATK's Cygnus, the Dream Chaser can land on a runway and can be re-used.

In 2014 NASA rejected the crewed version of the Dream Chaser in favour of the SpaceX and Boeing designs.

As a result of the NASA contract the European Space Agency (ESA) will enter into a cooperative agreement in which ESA will build the first flight model of the International Berthing and Docking Mechanism (IBDM), which the Dream Chaser Cargo System will use to attach itself to the space station.